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Improving Dairy Plant Procurement in a Competitive Dairy Market of Primorsky Krai

Irina Vasilevna Koval[1], Oksana Yuryevna Vinichuk[2], Svetlana Evgenyevna Savostina[3]*

[1]Far Eastern Federal University, 690922 Vladivostok, 22 (G) OPS Russian-2, Russian Federation, [2]Far Eastern Federal University, 690922 Vladivostok, 22 (G) OPS Russian-2, Russian Federation, [3]Far Eastern Federal University, 690922 Vladivostok, 22 (G) OPS Russian-2, Russian Federation. *Email: svetlana673@mail.ru

ABSTRACT

The article substantiates that the key element influencing the volume and structure of production of milk with specific fat content is well-organized dairy plant procurement. Its effectiveness depends on the principles of combining certain factors that determine the specificity of the regional dairy market. The present study is based on an evaluation of the features of procurement of about seven dairy plants in Primorsky Krai in order to develop an optimistic scenario for the development of the industry, minimize the costs of enterprises and maximize customer satisfaction. The present paper considers the problems of increasing the competitiveness of dairy products of JSC "Vladivostoksky Dairy Plant" by optimizing procurement. In particular, the needs of the regional market, suppliers of whole milk, as well as methods to optimize the volume of milk procurement taking into account the structure of demand for dairy products in Primorsky Krai and suppliers' ability to provide the main characteristics of the quality of raw milk are studied. For this purpose, the optimization model for procurement is developed in the study, which allows to flexibly respond to changing requirements of the market taking into account the capabilities of suppliers. The goal of the proposed method is in the application tools, which will allow regional dairy plants to adapt to market demands in terms of quality and fat content of the milk produced. Due to this, the model can be useful for many dairy producers, including the format of both large dairies and small farms.

Keywords: Milk Fat Content, Optimization Model of Procurement, Dairy Market of Primorsky Krai
JEL Classifications: Q18, Q13

1. INTRODUCTION

The main economic goal of the manufacturing enterprise is the production of competitive products. Realization of this goal depends largely on the organization of procurement of raw products, which should ensure high quality of the products based on the average fair prices prevailing on a particular regional market. Therefore, the efficiency of procurement activities may be regarded as one of the key elements of the strategic development of the company. Analysis of the strategic directions of development of dairy enterprises in the aspect of increasing the competitiveness of products is determined primarily by the following factors:

- Quality of milk, which is achieved through the use of natural milk and modern production technologies;
- Price, which depends on several factors: Cost of raw product, logistics costs, production organizational effectiveness, etc.;
- Organization of sales due to the selection of optimal marketing channels, with a low mark-up on sales and effective organization of the sales process. It is the development of measures to enhance the value of the product brand.

Analyzing the experience of foreign countries in the field of the problems faced by producers of milk, we can highlight the opinions of a number of authors who include the following in the basic parameters of milk quality: The microbiological constituents of milk, fat content, cows nutritional system, and risks of manufacturers in using veterinary drugs (Arcuri et al., 2006; Arunvipas et al., 2004; Bai et al., 2008; Barbano et al., 2006; Bonfoh et al., 2006; Borsanelli et al., 2014; Botaro et al.,

2008; Maksim et al., 2014). At the same time, fat content affects the volume of finished dairy products, as the bulk of milk is produced in the range of 1-6% fat, with the exception of cream and sour cream. Despite many factors that are specific to a particular country, there are common approaches to address key issues related to the quality of dairy products. By studying the approaches to the formation of a competitive milk production (Burgess, 2010; Broderick, 2003; Cassoli et al., 2010; Tamime et al., 2009; De Andrade et al., 2007), it becomes evident that the problems of healthy nutrition and milk quality are quite relevant for foreign manufacturers. They import their products to Russia, therefore it is necessary to understand the requirements to production. In turn, the works of the following authors are devoted to the key issues of the fat content of milk and its assessment methods (Eckstein et al., 2013; Griffiths, 2010; Kurajdova and Táborecka-Petrovicova, 2015; Schönfeldt et al., 2012; Schreiner and Latacz-Lohmann, 2015; Taffarel et al., 2015). They examine the issues of milk composition and quality in different types of storage and their change depending on the volume of its production, season and refrigerating system.

The modern wholesale dairy market of Primorsky Krai is characterized by a significant number of manufacturers and resellers of dairy products. Along with the large industrial enterprises (Vladivostoksky, Ussuriysky, Artemovsky and Spassky dairy plants) that were operating back in the period of the administrative-command system of economic management, there are now a significant number of new producers of dairy products, which are very close to raw product suppliers. They are such enterprises as Khorolsky dairy plant ("White Gold" LLC and "Green Leaves" LLC), Kirovsky, Chuguevsky, Milogradovsky, Surazhevsky dairy plants that largely process natural milk. This has increased the level of competition and led to a decrease in the share of "old" plants, including Vladivostoksky dairy plant in the market of Primorsky Krai. In order to maintain its market share, Vladivostoksky dairy plant needs new modern strategies of the business organization, which will provide a differentiated approach to ensure customer demand, taking into account their income and preferences.

In this regard, the study explored the possibility of procurement of whole milk in the agricultural areas of Primorsky Krai. The complexity of the study lies in the fact that the existing number of cows, both in farms and in the private sector, satisfies the market demand for only 30-40%, and in fact even less is used in the production. Large enterprises have no experience or developments on the rational organization of procurement. In essence, whole milk suppliers are a few farms that are organized on the basis of the state dairy farms with low productivity number of cows. The process of expanding the procurement area and the inclusion of small dairy farms require a precise calculation of procurement. Studies have shown that en masse milk offer on the market of raw products varies in fat content from 6% to 10%. Supply of more than 10% milk began only in the past 2-3 years due to the purchase of breeding cows, and at the moment it is a few tenths of a percent. Analysis of the needs of Primorsky Krai population in the finished dairy products showed that the demand for higher-quality types of dairy products made from whole milk increased. Therefore, it is advisable for each dairy plant to optimize its procurement, taking into account market factors, and provide an independent dairy group in its product range based on the possibility of purchasing whole milk.

2. METHODOLOGY OF THE STUDY

2.1. Evaluation of the Level of Concentration of Dairy Products Market of Primorsky Krai

To develop approaches for assessing the methods of management of procurement of the dairy plant (JSC "Vladivostoksky Dairy Plant" was taken for review), the level of concentration of the dairy products market of Primorsky Krai must be evaluated at the first step (based on the calculation of Herfindahl-Hirschman Index [HHI]). The statistics on the milk production by major producers (7 companies) was used for calculation. Dynamics of production of dairy products in Primorsky Krai totaled to 3241.77 million rubles in 2012, 3,328.13 million rubles in 2013, 3376.76 million rubles in 2014. The data show that each year the enterprises increase production. In part, this is due to the expansion of the product range. Then we will calculate the average share of each of the manufacturing enterprises in the city market in 2012-2014 on the basis of data provided by the Territorial body of the Federal State Statistics Service of Primorsky Krai (Table 1).

$$HHI = 10{,}000 \times \sum Y_i^2$$

$$HHI_{2012} = 10{,}000 \times (0.124096^2 + 0.129506^2 + 0.140025^2 + 0.21537^2) = 981.6301$$

$$HHI_{2013} = 10{,}000 \times (0.129525^2 + 0.136710^2 + 0.120304^2 + 0.215718^2) = 964.0383$$

$$HHI_{2014} = 10{,}000 \times (0.128469^2 + 0.137066^2 + 0.121232^2 + 0.213663^2) = 956.4068$$

These calculations show that HHI in 2012 – 800 < 981.6301 < 1800 – is low concentrated oligopoly, in 2013 – 800 < 964.0383 <

Table 1: Average share of a manufacturing enterprise in the dairy market in Vladivostok in 2012-2014

Plant name	Average share of the enterprise in Vladivostok market, %		
	2012	2013	2014
JSC "Vladivostoksky Dairy Plant"	0.124096	0.119322262	0.118495
JSC "Dairy Plant Ussuriysky"	0.129506	0.129252764	0.128469
CJSC "Pereyaslavsky Dairy Plant"	0.101247	0.104770547	0.106457
JSC City dairy plant "Artyomovsky"	0.140025	0.136710405	0.137066
LLC "Mikhailovsky Dairy Plant "	0.114493	0.115049592	0.114749
CJSC "Milovogradovo – 1"	0.117624	0.120304796	0.121232
LLC "White Gold" (Khorolsky dairy plant)	0.21537	0.215718737	0.213663
Others	0.057638	0.058870897	0.059868

1800 – is low concentrated oligopoly, in 2014 – 800 < 956.4068 < 1800 – is low concentrated oligopoly. Therefore, we can conclude that the market is dominated by a few fairly large dairy producers. The behavior of each of the producers depends on the reaction and behavior of competitors. In general, the market is considered low concentrated, and merges are freely allowed. The pricing strategy of JSC "Vladivostoksky Dairy Plant" depends on the actions of other market participants who limit its market power and force to resort to non-price forms of competition, which has a positive effect on the expansion of the product range. There were no facts of collusion of dairy producers in Vladivostok market. In the future, conclusion of secret agreements is also unlikely, as the costs and the range of products differ between the main producers. The main barrier to entry of new business entities into the market is the lack of a developed raw product base. The largest economic entities have strong economic ties with the raw product sellers and buyers of the goods produced, which gives them an advantage over potential competitors entering this market. One of the important conditions for increasing the competitiveness of the enterprise is to optimize procurement. For this purpose, it is first of all necessary to analyze the market share of milk producers (Table 2).

The data show that the largest share of the dairy market, which is 20.22%, is taken by LLC "White Gold" from Khorol and JSC "Vladivostoksky Dairy Plant" – 18.55%. However, it should be noted that JSC "Vladivostoksky Dairy Plant" occupies such a large share of the market mainly due to the sale of products outside Primorsky Krai – 53.13% of the base market. The rest of the dairy producers occupy approximately equal shares. To form competent procurement, the dairy plants need to observe the dynamics of change in their share over the years. The information obtained will allow them to choose the proper marketing strategy with respect to products and markets. It should be noted that the product range of dairy enterprises significantly expands every year. Basically, the new products are produced by large dairy plants: Vladivostoksky and Artemovsky.

The second stage of assessment of the situation is the change in the trend of increasing the share of milk powder in the total amount used in production. The main suppliers of milk powder from outside the region are Altai Krai, Omsk and Novosibirsk Oblasts, other regions of Russia, as well as Australia, New Zealand and USA. However, the introduction of economic sanctions against Russia and stronger dollar made the procurement of milk powder either impossible or uneconomical. As a consequence, this led to an increase in the value of products manufactured from milk powder in the domestic market. Therefore, well-organized procurement of whole milk should solve this problem.

Analysis of the situation showed that dairy products made from the skimmed milk powder and whole milk powder produced by JSC "Vladivostoksky Dairy Plant" almost do not differ by cost from the products made from natural milk, and are even more expensive. Since most people prefer products manufactured from natural milk, the demand for the products produced by JSC "Vladivostoksky Dairy Plant" falls and the plant loses its customers. The dairy plant needs to reduce the cost of production by reducing production costs and produce at least part of the goods or a separate brand name, such as "Merry Milkman," from natural milk. This is especially true in the summer and autumn period, when natural milk is available in sufficient quantities from regional producers.

In turn, the main producers of natural milk in Primorsky Krai are agricultural enterprises and private subsidiary farms, with the trend in the past decade being lower production volumes in all categories of farms (except private) (Table 3).

The data show that the production of natural milk in Primorsky Krai has dramatically reduced in recent years. In 2014, this figure relative to 2012 dropped by 53.48%, while milk production in private subsidiary farms dropped by 44.11%. All this determines the need for a more efficient use of natural raw milk in the production process, as well as for more accurately determining the needs of the population in different kinds of dairy products required for production.

2.2. Methods of Developing Programs of Whole Milk Procurement

In turn, the study of the preferences of buyers of dairy products that was conducted on the basis of a survey of consumers showed that the main factors influencing the purchase of dairy products are quality, price, shelf life, and the family budget. 230 questionnaires were prepared for a survey, which ensures the representativeness of sample. The survey was conducted on April 10-12, 2015 in

Table 2: Share of the main dairy producers in Primorsky Krai in 2014

Manufacturing enterprise	Share							
	Vladivostok		In the region		Outside the region		Sales volume on the base market, thousand rubles	Relative share, %
	Sales volume, thousand rubles	Relative share, %	Sales volume, thousand rubles	Relative share, %	Sales volume, thousand rubles	Relative share, %		
JSC "Vladivostoksky Dairy Plant"	400.13	12.6	397.46	14.06	542.41	53.13	1,340.00	18.55
JSC "Dairy Plant Ussuriysky"	433.81	13.66	352.11	12.45	0	0	785.92	10.88
CJSC "Pereyaslavsky Dairy Plant"	359.48	11.32	269.57	9.53	109.71	10.75	738.76	10.22
JSC City dairy plant "Artyomovsky"	462.84	14.57	429.58	15.19	101.43	9.93	993.85	13.76
LLC "Mikhailovsky Dairy Plant "	387.48	11.49	344.21	12.17	0	0	731.69	10.13
CJSC "Milovogradovo – 1"	409.37	12.12	386.74	13.68	0	0	796.11	11.02
LLC "White Gold" (Khorolsky dairy plant)	721.49	21.37	472.13	16.70	267.34	26.19	1,460.96	20.22
Others	202.16	5.99	175.23	6.20	0	0	377.39	5.22
Total	3376.76	100	2827.03	100	1020.89	100	7224.68	100

Table 3: Production volumes of natural milk in Primorsky Krai in 2012-2014

Index	Period, year						2014/2012, %
	2012		2013		2014		
	Volume, thousand tons	Relative share, %	Volume, thousand tons	Relative share, %	Volume, thousand tons	Relative share, %	
Milk production in all categories of farms	160.43	100	122.30	100	74.64	100	46.52
Including							
Private subsidairy farms	100.24	62.48	83.20	68.03	56.03	75.07	55.89

the retail network of Vladivostok. Only some users (not more than 15%) are influenced by advertising and package design. For example, 69% of respondents pay attention to product quality when buying dairy products; the price and shelf life are important for 40%. With factors such as quality, shelf life and price, JSC "Vladivostoksky Dairy Plant" may influence consumer behavior in the market of dairy products. This is the main thing that one needs to adopt to keep the position in this market. Currently, the price of the product is not so important for a significant portion of the buyers as the quality and composition of milk. At that, the indisputable majority of the respondents (42%) give preference to domestic production. 40% of consumers pay attention primarily to the shelf life and production date when buying. The shorter the shelf life is, the more natural the product is.

The analysis allowed to identify the main methods for developing the program of whole milk procurement. Since procurement is carried out under specially designed programs, the paper discusses each of the stages of the procurement program in more detail:

1. Market analysis, one of the elements of the procurement program for a dairy plant, includes: Research of the market of raw products, definition of the market size and competitors, systematic collection, processing, analysis and assessment of the information about suppliers
2. Analysis of capabilities of the dairy plant involves an analysis of capacities and financial condition. Capacities are often underutilized. It should be taken into account when forecasting the increased demand for goods and expanding the product range
3. Definition of the procurement scope and structure. The initial data for determining the material requirements is the production plan, manufacturing specifications, recipes used to calculate the demand for raw materials per unit of production, material resources consumption rates
4. Evaluation and selection of suppliers. The main criteria for the selection of suppliers for a dairy plant are quality and cost of raw products. The cost of the final product depends on these criteria
5. Determination of the optimal size of the order, i.e. the calculation of procurement volume. The dairy plant must monitor sales and take the seasonality into account
6. Contract work involves financial, organizational and legal support from the parent company. For example, TNK JSC "Wimm-Bill-Dann" may be unaware of all the local problems of JSC "Vladivostoksky Dairy Plant." Therefore, the support to meet the territorial interest must be effectively organized
7. Accounting and control are required to regulate the procurement: The fulfillment of the contract terms on deadlines, price, quality, range and other parameters by suppliers.

Thus, consumer demand is more and more individualized; many people prefer to choose products that meet their lifestyle, where the nutrition system plays an important role; the attention is focused on the calorie content and utility of food. About 3 years ago, the domestic dairy industry has changed dramatically - The Federal Law "Technical regulations on milk and dairy products" came into force, which to some extent influenced all market participants, both producers and processing enterprises. According to the technical regulations, a product containing in its composition anything other than milk cannot be called milk. Therefore, the reconstituted milk, well-known to our customer, is now referred to as "milk drink." It should be understood that a certain consumer culture has long developed in Russia, and people perceive dairy products as natural. The term "milk drink" has not yet found its place and, as a consequence, the product has not found its consumer.

In the past, before "Wimm-Bill-Dann" acquired a controlling stake, JSC "Vladivostoksky Dairy Plant" produced almost all products from natural milk, buying it from agricultural homesteads and farms. Today, links with Primorsky natural milk producers are lost, while purchasing natural milk from other regions is not profitable, especially during the warm season, because it is a great environment for the development of lactic acid and butyric acid bacteria. Dairy plant in Vladivostok needs to restore the lost links with local producers of natural milk: Farms, private households. The plant requires large amounts of natural fresh milk, which a single enterprise cannot give, so it needs to attract suppliers of dairy products such as Kirovsky, Chuguevsky, Milogradovsky, Surazhevsky dairy plants. The question arises on how the plant can now collect fresh milk from different manufacturers as quickly as possible on everyday basis.

One answer to this question is cooling or freezing of milk for transportation. Cryoscopic temperature for milk is −0.55°C. The growth of lactic acid bacteria that cause souring of milk is suspended at a temperature of about 10°C, and their development completely ceases at a temperature of 2-4°C. Freezing also helps stop the growth of bacteria in the milk, but later, after defrosting, many bacteria resume their activity. Milk can be cooled using either open or closed method with the use of technological equipment: Tanks of various capacities, plate and irrigation machines. Milk cooling below 0°C leads to rupture of the fat globule membranes and to the loss of part of the milk fat. Therefore, any milk cooling temperature should be lower than 6°C, and the cooling process must occur no later than 3 h after milking. In most regions of Russia, and in particular in

Primorsky Krai, cooled milk is accepted at a higher price compared to non-cooled. Therefore, JSC "Vladivostoksky Dairy Plant" can buy and install cooling tanks in the large farms. With the price difference between the cooled and non-cooled milk of only 1-2 rubles/L, the payback period for cooling tanks is 3-4 months. Further cooling of milk by tanks brings net income monthly.

It is also possible to install refrigeration units for milk of the gated horizontal design. They are fixed installations designed for the collection, intensive cooling of milk and its storage at low temperature. The mixing process is fully automated – It is carried out continuously during cooling and cyclic during storage. Milk cooling units are designed for two or four milkings. In the first case, the milk is poured into the unit in two steps, in the second – in four steps. After the second and each subsequent milking, warm milk is added to stored milk. The unit is gradually filled, and the mixture of warm and cooled milk is cooled to a temperature of +4°C and is then stored until the arrival of the milk tanker. Further, the milk tanker carries milk to the plant, where it passes sanity check and is sent to production. Milk cooling units will optimize the activity of JSC "Vladivostoksky Dairy Plant" and reduce storage costs. Procurement with the use of this equipment will reduce the cost of raw products. And since the plant partially shifts to production from natural milk, it will reduce the cost of the final product, expand markets and win a stable position in the market of dairy products.

2.3. Development of the Method for Calculating the Whole Milk Procurement Volume and Structure

Switching to whole milk as the main raw material for the production of 36% of products requires serious consideration of the procurement volume and structure. Forming the methodological support of the whole milk procurement requires to examine the quality of the offered milk by its fat content. As the analysis of offer showed, the maximum milk fat content is about 10%, and the optimum fat content is 6%. Table 4 shows the amount of the offered production of milk and dairy products with natural raw materials, according to the product sheet of JSC "Vladivostoksky Dairy Plant."

Table 4: Production program of JSC "Vladivostoksky Dairy Plant" for 2015

Types of products	Production volume (thousand tons per year)	Coefficient of milk consumption		
		6%	8%	10%
Sour cream 15%	0.2	2.6	2.2	2.0
Sour cream 20%	0.05	2.7	2.5	2.3
Cream 10%	0.1	2.2	2.0	1.8
Cream 15%	0.08	2.0	1.7	1.5
Butter milk 2.5%	1.0	0.8	0.7	0.5
Butter milk 3.2%	1.3	1.2	0.9	0.7
Curd 3.2%	0.25	3.4	3.0	2.8
Boiled fermented milk 3.2%	0.7	0.9	0.7	0.6
Sweetened yogurt 3.2%	0.3	0.7	0.6	0.5
Milk 6%	0.1	1.1	0.9	0.8
Milk 3.2%	2.2	0.7	0.5	0.4

The data in Table 4 show that the highest production volume of JSC "Vladivostoksky Dairy Plant" falls for milk 3.2% – 2200 t/year and butter milk 3.2% – 1300 t/year. The minimum production volume falls for milk 6%, cream 15%, sour cream 20%.

Further, based on the data from JSC "Vladivostoksky Dairy Plant," we can draft a timetable for milk delivery, taking into account the seasonality of consumption of dairy products by the population (Table 5).

By analyzing the above data, we can conclude that the consumption of dairy products reaches its peak in March and December. The decline in the consumption of dairy products in November and February is clearly traced. This indicates that the products are subject to the seasonality of consumption. To ensure the minimum cost of the annual volume of dairy products and take this into account in the preparation of the offer or the acceptance contract, you need to calculate the procurement volume for each type of milk. For example, the terms of supply of milk offered by the farm "Pioneer" to the plant are presented in Table 6.

As a result, it is seen that the price of finished products from whole milk depends on its fat content.

Next, we will estimate the cost price for each type of product in the future period, based on the fact that the cost of raw product is 60% of production costs on average. Comparing the cost estimation with the cost of production in the current period, we receive the following data (Table 7).

The data show that the greater the fat content of the product is, the higher its cost price is. For example, the most expensive product is curd 3.2%, the cheapest is milk 3.2%. These volumes and cost price allow to establish a new line of dairy products from natural raw products, which will attract new customers and increase the value of the company's brand.

3. RESULTS

The model of optimization of whole milk procurement can be compiled following the results of the study. To do this, we need to introduce the following notations:

m – Number of product types manufactured by the plant,

n – Number of types of milk,

y_{ij} – Annual volume of production of the i^{th} type in kg, made from milk of the j^{th} type ($i = \overline{1,m}$, $j = \overline{1,n}$),

a_{ij} – Coefficient of consumption of milk of the j^{th} type for production of the product of the i^{th} type,

Table 5: Consumption volume, taking into account the seasonality factor for dairy products of JSC "Vladivostoksky Dairy Plant" by consumers in Primorsky Krai in 2014

Months	1	2	3	4	5	6	7	8	9	10	11	12	Total per year
Consumption volume, %	8.5	7.9	9.1	8.6	8.3	8.2	8.1	8.2	8.3	8.2	7.6	9	100

b_i – Annual production of the product of the i^{th} type,
v_j – Annual volume of the milk of the j^{th} type offered by the farm,
c_j – Cost price of 1 L of milk of the j^{th} type (in rubles),
c – Cost price of milk required for the production of all dairy products during the year (in rubles).

Using these notations, we can find the annual volumes of each type of milk required for the production of all dairy products:

$$\sum_{i=1}^{m} a_{ij} y_{ij}, j = \overline{1,n} \quad (1)$$

Consequently, the cost price of milk is: $c = \sum_{j=1}^{n} c_j \bullet \sum_{i=1}^{m} a_{ij} y_{ij}$.

Given the production program of the dairy plant, we obtain restrictions on the production volumes for the products of the i^{th} type: $\sum_{j=1}^{n} y_{ij} \geq b_i, i = \overline{1,m}$.

Given the terms of supply, we can write down the restrictions for annual volumes of milk: $\sum_{i=1}^{m} a_{ij} y_{ij} \leq V_{j,} j = \overline{1,n}$.

Thus, the optimization model is as follows:

$$c = \sum_{j=1}^{n} c_j \bullet \sum_{i=1}^{m} a_{ij} y_{ij} \rightarrow \min \quad (2)$$

$$\sum_{j=1}^{n} y_{ij} \geq b_i, i = \overline{1,m}, \ \sum_{i=1}^{m} a_{ij} y_{ij} \leq V_j, y_{ij} \geq 0 \quad (3)$$

It is a linear programming task. In order to solve it using the simplex method, we need to get rid of double indices, i.e., redesignate the variables $y_{ij} = x_k$, $a_{ij} = d_k$, where, $k = n(i-1) + j$ (Table 8).

With the new notations, the optimization model takes the following form:

$$c = \sum_{j=1}^{n} c_j \sum_{i=1}^{m} d_{n(i-1)+j} x_{n(i-1)+j} \rightarrow \min \quad (4)$$

$$\sum_{j=1}^{n} x_{n(i-1)+j} \geq b_i, \ i = \overline{1,m}, \ \sum_{i=1}^{m} d_{n(i-1)+j} x_{n(i-1)+j} \leq V_j, \ j = \overline{1,n}, \ x_k \geq 0, k = \overline{1,mn.}$$

Using the Table 9, we can build a model for this task.

The sum of data from columns 2, 3, 4 of the first row in Table 9 is equal to the annual production volume of the 1st product. By hypothesis, this value should not be less than the production volume of the 1st product planned by the dairy plant, i.e. 200 kg (row 1, column 5). Consequently, the following condition must be met: $x_1 + x_2 + x_3 \geq 200$. Similar inequalities must be met for the first 11 rows in Table 9. The sum of data in column 6 (rows 1-11) in Table 9 is equal to the volume of milk 6% required for production of dairy products of all types. By hypothesis, this sum shall not exceed the amount of milk 6% (4200 kg) offered by the farm. Consequently, the following condition must be met: $2.6x_1 + 2.7x_4 + 2.2x_7 + 2.0x_{10} + 0.8x_{13} + 1.2x_{16} + 3.4x_{19} + 0.9x_{22} + 0.7x_{25} + 1.1x_{28} + 0.7x_{31} \leq 4200$.

Table 6: Calculation of procurement volume and cost of milk, JSC "Vladivostoksky Dairy Plant," 2014

Indicator	Milk type		
	6%	8%	10%
Procurement volume, tons	4.2	1.5	1.0
Cost price, rubles	9.5	9.8	12.4

Table 7: Cost price of products of JSC "Vladivostoksky Dairy Plant" in 2015

Types of products (%)	Cost price of 1 kg at the present time in rubles
Sour cream 15	42
Sour cream 20	50
Cream 10	40
Cream 15	46
Butter milk 2.5	30
Butter milk 3.2	36
Curd 3.2	55
Boiled fermented milk 3.2	38
Sweetened yogurt 3.2	37
Milk 6	20
Milk 3.2	10

Table 8: Variables for simplex method

1	2	3
$y_{11}=x_1$, $a_{11}=d_1$	$y_{12}=x_2$, $a_{12}=d_2$	$y_{13}=x_3$, $a_{13}=d_3$
$y_{21}=x_4$, $a_{21}=d_4$	$y_{22}=x_5$, $a_{22}=d_5$	$y_{23}=x_6$, $a_{23}=d_6$
$y_{31}=x_7$, $a_{31}=d_7$	$y_{32}=x_8$, $a_{32}=d_8$	$y_{33}=x_9$, $a_{33}=d_9$
$y_{41}=x_{10}$, $a_{41}=d_{10}$	$y_{42}=x_{11}$, $a_{42}=d_{11}$	$y^{43}=x_{12}$, $a_{43}=d_{12}$
$y_{51}=x_{13}$, $a_{51}=d_{13}$	$y_{52}=x_{14}$, $a_{52}=d_{14}$	$y_{53}=x_{15}$, $a_{53}=d_{15}$
$y_{61}=x_{16}$, $a_{61}=d_{16}$	$y_{62}=x_{17}$, $a_{62}=d_{17}$	$y_{63}=x_{18,}$ $a_{63}=d_{18}$
$y_{71}=x_{19}$, $a_{71}=d_{19}$	$y_{72}=x_{20}$, $a_{72}=d_{20}$	$y_{73}=x_{21}$, $a_{73}=d_{21}$
$y_{81}=x_{22}$, $a_{81}=d_{22}$	$y_{82}=x_{23}$, $a_{82}=d_{23}$	$y_{83}=x_{24}$, $a_{83}=d_{24}$
$y_{91}=x_{25}$, $a_{91}=d_{25}$	$y_{92}=x_{26}$, $a_{92}=d_{26}$	$y_{93}=x_{27}$, $a_{93}=d_{27}$
$y_{101}=x_{28}$, $a_{101}=d_{28}$	$y_{102}=x_{29}$, $a_{102}=d_{29}$	$y_{103}=x_{30}$, $a_{103}=d_{30}$
$y_{111}=x_{31}$, $a_{111}=d_{31}$	$y_{112}=x_{32}$, $a_{112}=d_{32}$	$y_{113}=x_{33}$, $a_{113}=d_{33}$

We must also consider similar restrictions for the data from columns 7 and 8. To write the objective function, the sum of data from column 6 (rows 1-11) must be multiplied by 9.5 rubles (cost price of 1l of milk 6%), the sum of data from column 7 (rows 1-11) must be multiplied by 9.8 rubles, the sum of data from column 8 by 12.4 rubles, and then we need to add up the results.

Target function:

$$C = (24.7x_1 + 25.65x_4 + 20.9x_7 + 19x_{10} + 7.6x_{13} + 11.4x_{16} + 32.3x_{19} + 8.55x_{22} + 6.65x_{25} + 10.45x_{28} + 6.65x_{31}) + (21.56x_2 + 24.5x_5 + 19.6x_8 + 16.66x_{11} + 6.86x_{14} + 8.82x_{17} + 29.4x_{20} + 6.86x_{23} + 5.88x_{26} + 8.82x_{29} + 4.9x_{32}) + (24.8x_3 + 28.52x_6 + 22.32x_9 + 18.6x_{12} + 6.2x_{15} + 8.68x_{18} + 34.72x_{21} + 7.44x_{24} + 6.2x_{27} + 9.92x_{30} + 4.96x_{33}) \rightarrow \min$$

Restrictions:
$x_1 + x_2 + x_3 \geq 200$

Table 9: Model for the task

Annual volume of product made from milk (kg)			Production volume (kg)	Volume of milk consumed in the production (kg per year)		
6%	8%	10%		6%	8%	10%
x_1	x_2	x_3	200	$d_1x_1=2.6x_1$	$d_2x_2=2.2x_2$	$d_3x_3=2.0x_3$
x_4	x_5	x_6	50	$d_4x_4=2.7x_4$	$d_5x_5=2.5x_5$	$d_6x_6=2.3x_6$
x_7	x_8	x_9	100	$d_7x_7=2.2i_7$	$d_8x_8=2.0x_8$	$d_9x_9=1.8x_9$
x_{10}	x_{11}	x_{12}	80	$d_{10}x_{10}=2.0x_{10}$	$d_{11}x_{11}=1.7x_{11}$	$d_{12}x_{12}=1.5x_{12}$
x_{13}	x_{14}	x_{15}	1000	$d_{13}x_{13}=0.8x_{13}$	$d_{14}x_{14}=0.7x_{14}$	$d_{15}x_{15}=0.5x_{15}$
x_{16}	x_{17}	x_{18}	1300	$d_{16}x_{16}=1.2x_{16}$	$d_{17}x_{17}=0.9x_{17}$	$d_{18}x_{18}=0.7x_{18}$
x_{19}	x_{20}	x_{21}	250	$d_{19}x_{19}=3.4x_{19}$	$d_{20}x_{20}=3.0x_{20}$	$d_{21}x_{21}=2.8x_{21}$
x_{22}	x_{23}	x_{24}	700	$d_{22}x_{22}=0.9x_{22}$	$d_{23}x_{23}=0.7x_{23}$	$d_{24}x_{24}=0.6x_{24}$
x_{25}	x_{26}	x_{27}	300	$d_{25}x_{25}=0.7x_{25}$	$d_{26}x_{26}=0.6x_{26}$	$d_{27}x_{27}=0.5x_{27}$
x_{28}	x_{29}	x_{30}	100	$d_{28}x_{28}=1.1x^{28}$	$d_{29}x_{29}=0.9x_{29}$	$d_{30}x_{30}=0.8x_{30}$
x_{31}	x_{32}	x_{33}	2200	$d_{31}x_{31}=0.7x_{31}$	$d_{32}x_{32}=0.5x_{32}$	$d_{33}x_{33}=0.4x_{33}$
Offered volume of milk (kg)				4200	1500	1000

$x_4 + x_5 + x_6 \geq 50$
$x_7 + x_8 + x_9 \geq 100$
$x_{10} + x_{11} + x_{12} \geq 80$
$x_{13} + x_{14} + x_{15} \geq 1000$
$x_{16} + x_{17} + x_{18} \geq 1300$
$x_{19} + x_{20} + x_{21} \geq 250$
$x_{22} + x_{23} + x_{24} \geq 700$
$x_{25} + x_{26} + x_{27} \geq 300$
$x_{28} + x_{29} + x_{30} \geq 100$
$x_{31} + x_{32} + x_{33} \geq 2200$
$2.6x_1 + 2.7x_4 + 2.2x_7 + 2.0x_{10} + 0.8x_{13} + 1.2x_{16} + 3.4x_{19} + 0.9x_{22} + 0.7x_{25} + 1.1x_{28} + 0.7x_{31} \leq 4200;$
$2.2x_2 + 2.5x_5 + 2.0x_8 + 1.7x_{11} + 0.7x_{14} + 0.9x_{17} + 3.0x_{20} + 0.7x_{23} + 0.6x_{26} + 0.9x_{29} + 0.5x_{32} \leq 1500;$
$2.0x_3 + 2.3x_6 + 1.8x_9 + 1.5x_{12} + 0.5x_{15} + 0.7x_{18} + 2.8x_{21} + 0.6x_{21} + 0.5x_{27} + 0.8x_{30} + 0.4x_{33} \leq 1000.$
$x_i \geq 0,\ i = \overline{1,33}$

This task can be solved using the simplex method implemented in Maple application package. The last parameter in these commands shows that input variables are non-negative, i.e., this design does not require to include conditions of non-negativeness of the variables in the restrictions. Before entering the minimize (maximize) command, the names can be assigned to the target function and a list of restrictions by using the assignment operator ": =" (in our example, the objective function is named as c, and the list of restrictions is named as restrictions). After running the minimize (maximize) command, the values of the variables $x_1, x_2 \ldots x_n$ are displayed on the screen (in blue). Request to the program for solving the task is as follows:

> with (simplex):

Target function:

> c: = 24.7*x_1 + 25.65*x_4 + 20.9*x_7 + 19*x_{10} + 7.6*x_{13} + 11.4*x_{16} + 32.3*x_{19} + 8.55*x_{22} + 6.65*x_{25} + 10.45*x_{28} + 6.65*x_{31} + 21.56*x_2 + 24.5*x_5 + 19.6*x_8 + 16.66*x_{11} + 6.86*x_{14} + 8.82*x_{17} + 29.4*x_{20} + 6.86*x_{23} + 5.88*x_{26} + 8.82*x_{29} + 4.9*x_{32} + 24.8*x_3 + 28.52*x_6 + 22.32*x_9 + 18.6*x_{12} + 6.2*x_{15} + 8.68*x_{18} + 34.72*x_{21} + 7.44*x_{24} + 6.2*x_{27} + 9.92*x_{30} + 4.96*x_{33}

Restrictions:

> Restrictions: = {$x_1 + x_2 + x_3$ >= 200, $x_4 + x_5 + x_6$ >= 50, $x_7 + x_8 + x_9$ >=100, $x_{10} + x_{11} + x_{12}$ >= 80, $x_{13} + x_{14} + x_{15}$ >= 1000, $x_{16} + x_{17} + x_{18}$ >= 1300, $x_{19} + x_{20} + x_{21}$ >= 250, $x_{22} + x_{23} + x_{24}$ >= 700, $x_{25} + x_{26} + x_{27}$ >= 300, $x_{28} + x_{29} + x_{30}$ >= 100, $x_{31} + x_{32} + x_{33}$ >= 2200; 2.6*x_1 + 2.7*x_4 + 2.2*x_7 + 2.0*x_{10} + 0.8*x_{13} + 1.2*x_{16} + 3.4*x_{19} + 0.9*x_{22} + 0.7*x_{25} + 1.1*x_{28} + 0.7*x_{31} <= 4200, 2.2*x_2 + 2.5*x_5 + 2.0*x_8 + 1.7*x_{11} + 0.7*x_{14} + 0.9*x_{17} + 3.0*x_{20} + 0.7*x_{23} + 0.6*x_{26} + 0.9*x_{29} + 0.5*x_{32} <= 1500, 2.0*x_3 + 2.3x_6 + 1.8*x_9 + 1.5*x_{12} + 0.5*x_{15} + 0.7*x_{18} + 2.8*x_{21} + 0.6*x_{24} + 0.5*x_{27} + 0.8*x_{30} + 0.4*x_{33} <= 1000};

Minimize (c, Restrictions, Non-negative)

The strings "Target function:" and "Restrictions" are comments. Press "Enter" after making request, and the values found for the following variables will be displayed on the screen: $x_1, x_2 \ldots x_{33}$.

To display the value of the target function c, you must enter the following command:

> subs (%,c) and press "Enter"

The calculation results presented in columns 2, 3, 4 in Table 10 allow to find the volumes of each type of milk (columns 5, 6, 7 of Table 10) required to produce each product type using the formula:

Milk consumption = Coefficient of milk * Production volume (5)

Estimates of the cost price of products in the future period (column 8 of the table) were calculated using the formula:

$$\text{Cost price of the product} = \text{Cost price of milk consumed for the product per year} * \frac{100}{60} \div \text{production volumes of the product per year} \quad (6)$$

For example, the cost price of milk 3.2% was determined as follows:

$$(1010 \bullet 9.8 + 72 \bullet 12.4) \bullet \frac{100\%}{60\%} \div 2200 \approx 8.1748 \approx 8.17 \text{ rubles}$$

The sum of the values from the last row of Table 10 determines the annual costs of the dairy plant for milk procurement, i.e. a minimum of the target function: 28,273.9 + 14,700 + 12,400 = 55,373.9 rubles.

Using the data, we can determine the amount of dairy plant costs for each quarter separately (Table 11).

This method will ensure the procurement monitoring. The costs for natural milk procurement amounted to 55,373.85 thousand rubles per year. This will ensure 23.8% of production of products from whole milk, which is a small proportion. This creates the opportunity to capture the market share of milk production in Vladivostok of manufacturers such as LLC "White Gold," JSC City dairy plant "Artyomovsky," JSC "Dairy Plant Ussuriysky." If we compare the costs of the equipment renewal and design of a new technological line for production of natural whole milk and the profits that JSC "Vladivostoksky Dairy Plant" will receive, the return at the expense of net profit will be 2-3 years.

4. DISCUSSION

According to research conducted in the paper, it can be argued that these costs are justified, and if these measures are not taken now, JSC "Vladivostoksky Dairy Plant" will be expelled from Vladivostok market after 5 years. Thus, successful procurement requires a strategic approach to the organization of the functioning of a dairy plant in the regional market, i.e. it is necessary to consider the capabilities of competitors and the own potential. Procurement of raw products is of particular importance, since it is the basis of quality and cost price of products. Enterprise in modern conditions must timely and thoroughly conduct the comprehensive analysis of the market of raw products, as well as the systematic study of suppliers. When planning the procurement, the main challenge JSC "Vladivostoksky Dairy Plant" faces is procurement of high-quality and relatively inexpensive raw products that meet all standards and will ensure the competitiveness of manufactured dairy products.

Based on studies of foreign authors, the following main approaches to the definition of the quality characteristics of milk in the formation of the model of procurement for a dairy plant can be highlighted:

- Analysis of the quality of milk depending on the quality of milk production processes on farms (Adjlane-Kaouche et al., 2014; Bargo et al., 2002; Botaro et al., 2013; Ellis et al., 2007; Fuentes et al., 2014)
- Assessment and identification of factors influencing the quality of milk (Belli et al., 2013; Pistocchini et al., 2009; Schukken et al., 2003; Takahashi et al., 2012; Young et al., 2010).

Factors that influence the formation of the optimization model have their specificity for the milk market and consumers who choose specific dairy products. These factors can vary significantly depending on the behavior of consumers, as evidenced by the foreign practice (Ates and Ceylan, 2010; Charlebois and Haratifar, 2015; Fawi and Abdalla, 2013; Senadisai et al., 2015; Unahanandh and Assarut, 2013).

It is quite important for dairy producers to use the proposed tools that will allow to adapt their activities to environmental factors

Table 10: Data calculation

Product type	Annual volume of product from milk, kg			Milk consumption, kg			Cost price of product, rubles	
	6%	8%	10%	6%	8%	10%	Present period	Future period
Sour cream 15%	x_1=200	x_2=0	x_3=0	d_1x_1=520	d_2x_2=0	d_3x_3=0	42	41.17
Sour cream 20%	x_4=50	x_5=0	x_6=0	d_4x_4=135	d_5x_5=0	d_6x_6=0	50	42.75
Cream 10%	100	0	0	220	0	0	40	34.83
Cream 15%	80	0	0	160	0	0	36	31.67
Butter milk 2.5%	964	0	36	771,2	0	18	16	12.58
Butter milk 3.2%	0	0	1300	0	0	910	36	14.47
Curd 3.2%	250	0	0	850	0	0	55	53.83
Boiled fermented milk 3.2%	0	700	0	0	490	0	38	11.43
Sweetened yogurt 3.2%	300	0	0	210	0	0	37	11.08
Milk 6%	100	0	0	110	0	0	20	17.42
Milk 3.2%	0	2020	180	0	1010	72	10	8.17
Consumption of milk for all types of products, kg				2976.2	1500	1000		
Cost price of 1 L of milk, rubles				9.5	9.8	12.4		
Cost of milk (in rubles per year)				28,273.9	14,700	12,400		

Table 11: The costs of JSC "Vladivostoksky Dairy Plant" on a quarterly basis, 2015

Quarter #	Consumption, %	Consumption of milk, kg			Cost price of milk, thousand rubles			Total, thousand rubles
		6%	8%	10%	6%	8%	10%	
1	25.5	758.93	382.5	255.0	7209.84	3748.5	3162.0	14,120.34
2	25.1	747.02	376.5	251.0	7096.75	3689.7	3112.4	13,898.85
3	24.6	732.14	369.0	246.0	6955.33	3616.2	3050.4	13,621.93
4	24.8	738.10	372.0	248.0	7011.93	3645.6	3075.2	13,732.73

(mainly economic and political), taking into account international experience, and improve their procurement activities on the principles of efficient logistics and search for the best suppliers of raw products.

5. CONCLUSION

The dairy plant conducts procurement on the basis of a general strategy of "Wimm-Bill-Dann," which has defined the procurement volume for all Russian enterprises that are subsidiaries of the company. This policy of the company makes powder milk more expensive than natural or in the same price segment with it. Since most people prefer products manufactured from natural milk, the demand for the products produced by JSC "Vladivostoksky Dairy Plant" falls and the plant loses its customers. The dairy plant needs to reduce the cost of production by reducing production costs and produce at least part of the goods or a separate brand name, such as "Merry Milkman," from natural milk. The dairy plant in Vladivostok needs to restore the lost links with local producers of natural milk: Farms, private households. By implementing the proposed algorithm of work on the optimum combination of factors into its procurement activities, the dairy plant can be more responsive to consumer demand by offering them the production version, which is the most popular at the moment in the market.

So, on the identified issues, we can offer dairy plants of Primorsky Krai the following tools for improving procurement activities in order to increase production volumes of products from whole milk:

1. Switch to the production of products from natural milk in the conditions of shortage of raw products; it is advisable to organize a new line of eco-friendly products in the first stage, which will provide an increase in the price of the dairy plant's brand;
2. Restore the lost links between the dairy plants and producers of natural milk in Primorsky Krai, and participate in the process of production of raw milk in the future;
3. Purchase and install refrigeration systems for the collection and cooling of milk in large agricultural farmsteads, which will allow for the procurement without intermediaries;
4. Carry out calculation of the optimal demand for raw products by using the simplex method implemented in Maple application package.

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